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Donna Creek Forestry/Biodiversity Project: Habitat Use of Cavity Nesting Birds in The Donna Creek Study Area, 1995

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ABSTRACT

Habitat use and nest search surveys were conducted in 1995 as part of the Donna Creek Forestry/Biodiversity Project in the Essfmv3 240 km north of Prince George, B.C. Four different harvesting methods were applied to each of three cutblocks in the Donna Creek drainage: three metre stumps (stubs), tree retension areas (tree islands), both stubs and tree islands, or neither (clear-cut). The study examined which structural elements retained after harvesting provided habitat for members of the cavity nesting guild. Ten minute sets of observations taken at 20 second intervals (time series) noting behaviour and habitat use were recorded during the 1995 breeding season. Nest searches for cavity nesting species were also conducted in the cutblocks. Six of the seven cavity nesting birds recorded in the cutblocks nested in at least one treatment in the study blocks. With the exception of tree swallows *(Tachycineta bicolor)* all cavity nesting species preferred foraging in the treatment areas relative to clear-cut control areas. Mountain bluebirds *(Sialia currucoides)preferred* treatments with stubs for foraging and nesting. Three-toed woodpeckers *(Picoides tridactylus)* nested in the tree islands but preferred the old-growth adjacent to the cutblocks for foraging. Black-backed woodpeckers *(Picoides arcticus)* were less adverse to the logging treatments nesting further from the old-growth and foraging extensively in the stub treatments. Tree swallows utilized the stubs and tree islands in the cutblocks primarily for nesting. American kestrels *(Falco sparverius*) were not found to nest in the study blocks but were observed using stubs, tree islands, and small trees as foraging perches in all treatment areas but not in clear-cut areas. In this study the extensive use of the stubs and residual tree islands by the five target species (three-toed woodpecker, black-backed woodpecker, mountain bluebird, tree swallow and American kestrel) illustrate their importance to the cavity nesting guild. From a management perspective, retention of the structural complexity provided by stubs and residual tree islands can only be beneficial to cavity dependent species.

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1.0 INTRODUCTION

Breeding birds disperse their nests in a variety of patterns ranging from the tightly clumped distribution of colonial species to the uniform distribution of territorial species (Muldal *et al.* 1985). The spatial distribution of resources such as food, nest sites, and nest materials; the intraspecific competition for these resources and for mates; and predation pressure are some of the factors determining the breeding dispersion of individuals (Crook 1965, Hoogland and Sherman 1976). Those species that build their own nests have some choice in the nature of their association with conspecifics, and intraspecific interactions are probably the most important determinants of their dispersion patterns (Muldal *et al.* 1985, Snap 1976). Black-backed *(Picoides arcticus)* and three-toed *(Picoides tridactylus)* woodpeckers are examples of cavity nesting species which build their own nests (Marshall 1992, Goggans *et al.* 1988). Those species that must nest in existing holes and cavities have distributions determined primarily by the availability of suitable nest sites (Holroyd 1975). For example, tree swallows *(Tachycineta bicolor)*, American kestrels *(Falco sparverius*), and mountain bluebirds *(Sialia currucoides)* are dependent on the availability of secondary or natural cavities for nest sites (Muldal *et al.* 1985, Scott *et al.* 1977).

The Donna Creek Biodiversity Project is an attempt to gauge and compare the effects of alternative timber harvesting techniques on bird and mammal communities. The study took place in the Donna Creek Drainage, an area in north central British Columbia, west of the Williston Reservoir. The project was designed to examine if structural elements remaining in clear-cut blocks could provide habitat for wildlife species. Four different harvesting methods were applied to each of three cutblocks in the Donna Creek drainage: three metre stumps (stubs), tree retension areas (tree islands), both stubs and tree islands, or neither (clear-cut) were retained within the cutblocks.

The avian portion of the project included three parts: breeding bird surveys, habitat use sampling, and cavity-nest searches. Breeding bird surveys were conducted to compare bird communities in the different treatment areas; results are discussed elsewhere in Gyug and Summers (1995) and Gyug (1996). The objectives of habitat use sampling and cavity nest searches were to evaluate treatment use and nest site selection in cavity nesting species. Results of these surveys are the subject of this report.

Cavity nesting species were chosen as a target group due to their importance as keystone species in forest communities. Forest management techniques that maintain populations of these birds after timber harvesting activities are important for a number of reasons. Primary cavity nesting species provide essential breeding, roosting, and hibernating habitat for secondary cavity users (Bull *et al.* 1986). In addition, cavity nesting birds are important predators of forest pests and play a critical role in the maintenance of forest health (Machmar and Steeger 1995).

Cavity nesting birds use of the treatment areas and preferences for retained structural elements were examined. Nest searches were conducted to establish whether the treatment areas were being used for reproductive purposes, and to determine nesting distribution patterns, and nest site preferences of the target species. 1995 was the first year that habitat use and nest search data were collected in the Donna Creek drainage.

2.0 STUDY AREA

The Donna Creek drainage is located at the southern tip of the Wolverine Range on the west side of the Williston Lake Reservoir in north central British Columbia. The drainage falls within the moist, very cold Engelmann Spruce Subalpine Fir (ESSFmv3) biogeoclimatic zone. The study area is located within the Donna Creek drainage and all cut blocks and control areas are located on the northeast side of the valley. (Figure 1.)

Figure 1. Location of the Donna Creek Study area in British Columbia.

3.0 STUDY DESIGN

The study design included four different harvesting methods applied to each of three treatment blocks (5516, 5546, 5547) in the Donna Creek drainage. On one quarter, eight to ten 3 metre tall stumps per hectare were left (Stub treatment: SB). Another quarter had tree retention areas (that included some stubs left at the perimeters to feather the effect of the adjacent clear-cuts) occupying about 3% of the total treatment area

(Tree Island treatment: TI). The third quarter had a combination of eight to ten three metre stubs per hectare and tree retension areas (Stubs and Island treatment: SI). The fourth quarter was a traditional clear-cut treatment (clear-cut: CT). For comparison with the treatment blocks, three blocks (5510, 5549, and 5550) that were entirely clear-cut (CC), and three old-growth areas (OG) were also sampled. The study examined which structural elements retained after harvesting provided habitat for members of the cavity nesting guild. The treatment blocks range in size from 90.6 ha to 113 ha, in elevation from 1000m to 1330m, and in slope from 13% to 24% (Wood 1992).

Detailed study design information and block characteristics can be found in Dawson *et al.* (1992), Wood (1992,1994) Gyug and Summers (1995), Joy and van den Driessche 1995, and Gyug (1996).

4.0 METHODS

4.1 Sampling Design

Sets of observations recorded at specified intervals (time series) were collected on selected cavity nesting species to provide habitat use and distributional data. Survey methodology for the time series involved following a selected cavity nesting bird for 10 minute periods and recording both behaviour and habitat use at 20 second intervals. Due to the small sample size of cavity nesting birds in each block, birds could not be randomly selected. Instead, time series were collected on the first cavity nesting individual located.

Habitat use time series were recorded for three-toed woodpeckers , black-backed woodpeckers, American kestrels, mountain bluebirds, and tree. American kestrels and tree swallows were often difficult to track for the full 10 minute time series due to their mobile nature and large territory size. As the time series were not treated as independent samples in the analysis, incomplete time series (time-series that endured less than 10 minutes) were included in the results.

One of the three treatment blocks was surveyed each day between May 29th through June 25th, with a different treatment block visited each day (5516, 5546 or 5547). Equal sampling time was spent in each of the three treatment blocks. Habitat use surveys were conducted in Stub (SB), Tree Island (TI), Stub and Island (SI) treatments and Clear-cut (CC) control areas. Surveys were not specifically conducted in old-growth areas due to potential bias as a result of differences in detectibility. These species were highly mobile and virtually impossible to track in the poor visibility of the old-growth. However, if birds entered the old-growth during a time-series, the amount of time spent there was recorded.

An equal amount of time was spent in each of the three treatment areas and the clear cut control area. Survey data of some species could not be collected in all of the treatment areas as they were not randomly distributed across the cutblocks. Some cavity nesting species preferred certain treatments and avoided others. Furthermore, as the distribution of birds was largely related to their nest locations, time series were inextricably tied to the distribution of active cavity nests and were often first located in the vicinity of the nest. The small sample size of individuals also meant that within a block, multiple time series were collected on the same individual.

Three people were involved in the habitat use surveys: two observers followed the bird calling out the behaviour and habitat structures and one recorded the information on a data form.

Behaviours were grouped into perching, foraging, flying, calling, nesting, mating, and preening categories in each treatment area. A classification of behaviours can be found in Table 1.

Table 1 Description of behaviour groupings recorded during the Donna Creek habitat use surveys.

Behaviour	Description of Behaviour
Perching	Resting without moving on a habitat feature
Foraging	Obtaining food either by gleaning or pecking (woodpeckers), ground-feeding or flycatching (mountain bluebirds), or airborne hunting (American kestrels)
Preening	Cleaning or ruffling feathers
Calling	Emitting a vocalization
Flying	Airborne movement not involved in foraging
Nesting	Feeding young, constructing nest cavites, entering a cavity
Mating	Performing mating acts and rituals

4.2 Analysis

Treatment use was analysed individually for the three-toed woodpecker, black-backed woodpecker, American kestrel, mountain bluebird, and tree swallow. Due to small sample sizes, data were analyzed by species and treatment type only, and not stratified by sex, time, or date. In particular, for each species, time series were not separated by treatment block but collated into one data series per treament (ie. all time series in the SI treatment of blocks 5516, 5546, and 5547 were pooled for the analysis). Results are presented as the percentage of total observed time.

4.3 Nest searches

An attempt was made to locate nests of all cavity nesting birds in the treatment blocks and in the immediate old-growth. Nests were incidentally located during the habitat use surveys and during point count surveys. Actual nest searches were also conducted throughout the treatment blocks after morning point counts were complete and for the duration of the breeding season. Nests were found by following cavity nesting birds within the study blocks until their nests were located or the birds had left the study area. Nest locations were mapped to determine any trends in nest site distribution.

5.0 RESULTS:

Cavity nesting birds in the Donna Creek study area for which habitat use and nest site data were collected, included three-toed woodpeckers, black-backed woodpeckers, mountain bluebirds, and tree swallows (Table 2). Habitat use data were also collected for American kestrels but no nest was located. Results of habitat feature use by all cavity nesting species surveyed is summarized in Table 3. Additional cavity nests of Red-breasted Nuthatches (*Sitta canadensis)* and Hairy Woodpeckers *(Picoides villosus)* were incidentally found but no habitat use data were collected for these species as they were not found in the treatment blocks during the habitat use survey period (Table 4).

Table 2. Overall use of the Donna Creek treatment areas by cavity nesting species.

Species	SB Treatment	TI Treatment	SI Treatment	CC Treatment	OG Treatment
three-toed woodpecker	NR	68	NR	NR	32
black-backed woodpecker	60	NR	NR	NR	40
mountain bluebird	72	NR	5	5	NR
tree swallow	76	5	NR	NR	9
American kestrel	27	35	NR	NR	1

NR = not recorded in a particular treatment during habitat use surveys.

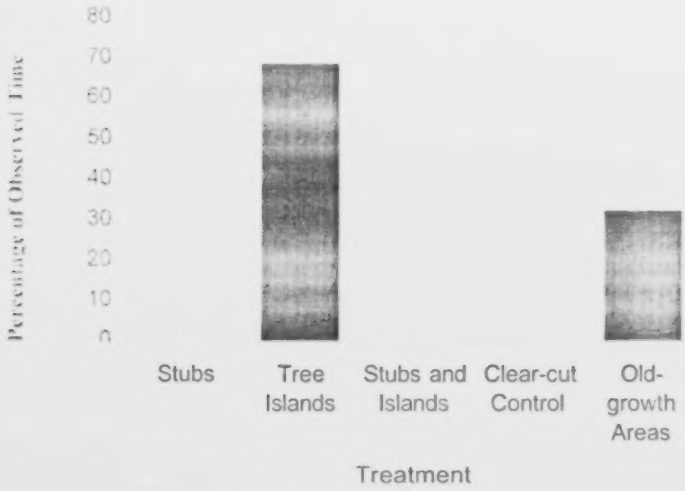
5.1 Three-toed Woodpecker

Three-toed woodpeckers were observed for a total of 32 minutes in TI treatments (68%) and the old-growth areas (32%) surrounding the treatment blocks. They were not observed in SB treatments or CC controls during the behavioural surveys. Three-toed

woodpeckers were observed using live trees and stubs, spending more time in live trees than on stubs.

Nine three-toed woodpecker nests were found; six in old-growth, two in TI treatment and one in SB treatment. Four were drilled in live trees, three in stubs (two in stubs at the edge of tree islands, one in the old-growth stub treatment boundary) and two in snags. The nest found in the SB treatment was near the stub treatment old-growth boundary however no 10 minute habitat use time series could be collected on this pair as it did not appear to use the cut-block except for nesting and shuttling between the nest site and the old-growth.

Figure 2. Percentage of observed time spent in the different treatment types by three-toed woodpeckers.



Tree Island (TI) Treament

In TI treatments, three-toed woodpeckers spent the majority of observed time nesting (54%) or calling (31%) and the remaining time was spent foraging (9%), perching (3%) or flying (3%). In this treatment three-toed woodpeckers were seen most often on live trees (89%) but were also observed using the stubs at the edge of the tree islands (10%). Nesting in the treatment occurred exclusively on stubs left at the perimeter of the tree islands.

5.2 Black-backed Woodpecker

Black-backed woodpeckers were observed for a total of 66 minutes during the survey period in SB treatments (60% of observations) and old-growth areas (40%) that surrounded the treatment blocks. Five black-backed woodpecker nests were found in three of the treatments; SB (2), TI (1), and SI (2). We found no Black-backed woodpecker nests in old-growth forests. Two nests were drilled in stubs, two in snags, and one in a live tree.

Figure 3. Percentage of observed time spent in the different treatment types by black-backed woodpeckers.

Stub (SB) Treatment

Black-backed woodpeckers were observed nesting (72%), perching (13%), calling (7%), foraging (7%), and preening (1%) in the Stub Treatment. The habitat structures used were stubs (89%), slash (8%), ground (2%), and live trees (1%).

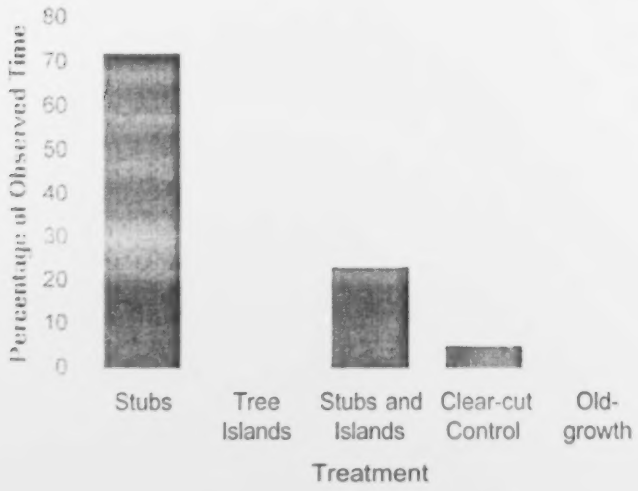
5.3 Mountain Bluebird

Observations of mountain bluebirds took place for 237 minutes during the survey period. The majority of time was split between the SB treatments (72%) and SI treatments (23%). However, mountain bluebirds were also observed using CC control areas (5%),

but not the TI treatment. Mountain bluebirds were most frequently observed on stubs but also used live trees, ground, slash, stumps,dead trees, and shrubs.

Five nests were found; all nests were in treatment types that contained stubs. There were three nest in the SB treatments and two nests in the SI treatments. Three nests were in stubs and two nests were in snags at the edge of islands. All five mountain bluebird nests were located well away from the old-growth/treatment block boundary.

Figure 4. Percentage of observed time spent in the different treatment types by mountain bluebirds.



Stub (SB) Treatments

Mountain bluebirds were most often observed perching (57%) in the SB treatments. Other behaviours observed were flying (12%), nesting (11%), foraging (10%), calling (2%), mating (0.5%) preening (0.5%) and unknown behaviours (7%). Mountain bluebirds showed a strong preference for stubs as perches in the SB treatment (78%). Slash, stumps, live trees, ground, dead trees and logs accounted for 9%, 6%, 5%, 1%, 0.7% and 0.3% respectively.

The three nests found in these treatments were all located in stubs. All mating and nesting behaviour took place exclusively on stubs.

Stub and Islands (SI) Treatments

Mountain bluebirds were most often observed perching (77%) in the SI treaments, but also flying (12%), foraging (11%), and nesting (1%) in these treatments. Mountain bluebirds preferred live trees (48%) for perching over stubs (17%), slash (17%), dead trees (8%), stumps (6%), shrubs (2%), and the ground (2%). Foraging behaviour was split

between gleaning insects from the ground (94%) and flycatching in the air (6%). Observed nesting behaviours took place exclusively on snags.

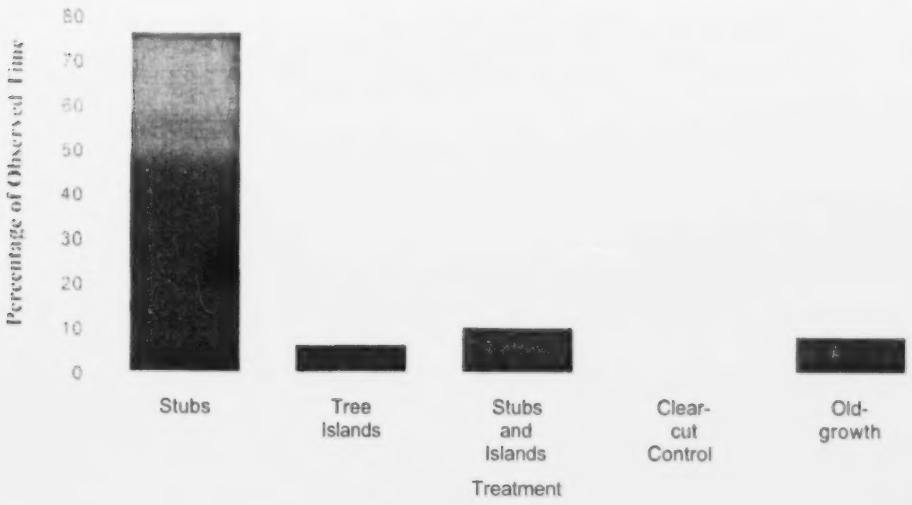
Clear-cut (CC) Controls

Perching (74%), foraging (21%), flying (3%), and unknown (2%) behaviours were recorded in the CC control areas. Perching was the only behaviour for which habitat use could be evaluated in this treatment. Live trees (71%) were the preferred habitat feature for perching. Dead trees (14%), slash (11%) and stumps (4%) accounted for the remaining perching observations in clear-cut areas.

5.4 Tree Swallow

Seventy minutes of tree swallow observations took place during the survey period. Tree swallows were observed predominately in or over the SB treatments (76%), but also SI treatments (10%), old-growth (9%), and TI treatments (5%). This species forages almost exclusively in the air, and the majority of observations in each of the treatments in which it was observed were on the wing (74.1% of total survey time). Habitat structures used by this species included stubs and snags for nesting as well as stubs, live trees, and stumps for perching and calling.

Figure 5. Percentage of observed time spent in the different treatment types by tree swallows.



Four tree swallow nests were found; three in stubs and one in a snag. These nests were built in CC (1 in the only 3m stub in the block), SB (2 in stubs), and TI (1 in snag inside a tree island) treatments.

Stub (SB) Treatment

Tree Swallows were observed foraging (39%), flying (32%), nesting (17%), perching (9%), and calling (3%) in the stub treatment. Perching behaviour occurred on stubs (91%) and stumps (9%). Calling occurred on stubs 75%) and live trees (25%). Nesting behaviours took place solely on stubs.

Stubs and Islands (SI) Treatment

Foraging (65%), flying (18%), perching (12%), and unknown behaviours (5%) were observed in the SI treatment. Tree swallows were only observed perching on stubs in the SI treatment.

Tree Island (TI) Treatment

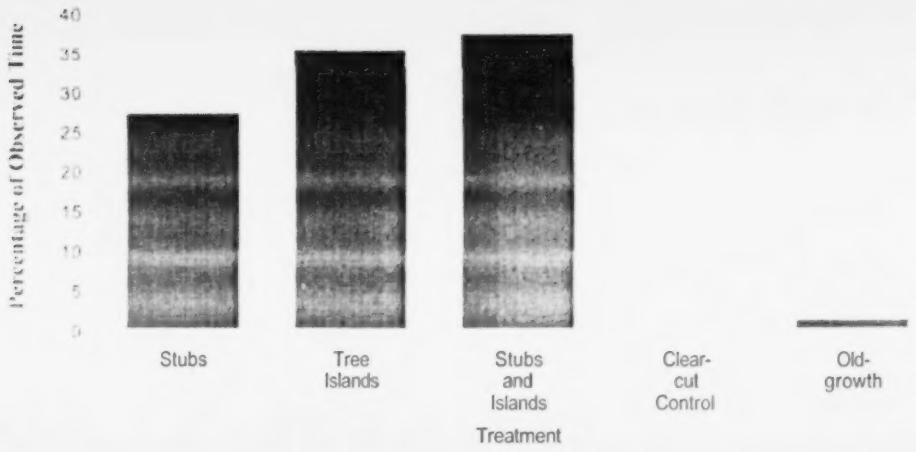
The only activities observed in this treatment were aerial activities such as flying (37%) and foraging (63%). The one nest in this treatment type was in a large snag within a tree island.

5.5 American kestrel

American kestrels were observed for a total of 9 minutes and 30 seconds during the habitat use surveys. They spent time in SI treatment (37%), in TI treatment (35%), in SB treatment (27%) and in old-growth areas. American kestrels used stubs, snags, stumps, and live trees in the different treatment areas.

No nest was found for the American kestrel pair observed using the treatment blocks despite exhaustive searches, and it was concluded that they were not nesting within the study area.

Figure 6. Percentage of observed time spent in the different treatment types by American kestrels



Stubs and Islands (SI) Treatments

In SI treatments, American kestrels were observed mostly perching (50%) and flying (42%) but also foraging (5%), calling (2%), and unknown (1%). American kestrels perching in the SI treatment were recorded on stubs (80%), and in live trees (20%). All American kestrels called from the ground in the SI treatment.

Stub (SB) Treatments

Within the Stub treatments perching (52%), flying (30%), foraging (9%), and unknown behaviours (9%) were observed. Perching activities were observed on stubs (52%), live trees (44%), and stumps (4%).

Tree Island (TI) Treatments

American Kestrels used Tree Island treatments predominately for perching (96.4%), preening (1.8%), and flying (1.8%) activities were also recorded. All American kestrels perching and preening were observed on snags.

5.6 Red-breasted Nuthatch

The two red-breasted nuthatch nests located in the study area were both in close proximity to the old-growth, one in the old-growth/block boundary edge and the other in an island quite close to the old-growth. No habitat use information was collected for this species as it was not detected within the blocks during habitat use surveys.

5.7 Hairy Woodpecker

The single hairy woodpecker nest found in the treatment blocks was in an island near the centre of block 5547. This was the only hairy woodpecker pair found within the study blocks. Habitat use information was not collected for this species as it was not detected during habitat use surveys.

Table 3. Percentage of total observed time spent using particular habitat features in specific treatments by cavity nesting birds in the Donna Creek study area.

Species	Habitat Feature	TI Treatment	SB Treatment	SI Treatment	CC Treatment
Three-toed woodpecker	stub	13%			
	live tree	84%		100%	
	unknown	3%			
Black-backed woodpecker	stub		89%		
	live tree		1%		
	ground		2%		
	slash		8%		
Mountain bluebird	stub		57%	14%	
	live tree		2.5%	37%	53%
	air		1%	13%	3%
	stump		4%	5%	3%
	ground		8.5%	11%	21%
	dead tree		0.5%	5.5%	10%
	log		0.5%		
	slash		6%	13%	8%
	shrub			1%	
	unknown		7%	0.5%	2%
tree swallow	stub		28%	12%	
	live tree				
	air	100%	71%	83%	
	stump		1%		
	unknown				
American kestrel	stub		27%	40%	
	live tree		23%	10%	
	air	2%	39%	46%	
	stump		2%	2%	
	ground				
	snag	98%			
	unknown		9%	2%	

Table 4. Characteristics of active cavity nests located in the Donna Creek study area.

Species	Block	Treatment	Habitat Feature	Cavity Height	Distance to Treatment Boundary (Metres)	Tree Species
TTWO	5546	OG	live tree	11	10	Engelmann Spruce
TTWO	5547	TI	stub	2.5	100	Engelmann Spruce
TTWO	5547	SB/OG	snag	12	0	Lodgepole Pine
TTWO	5516	OG	snag	3	20	Subalpine Fir
TTWO	5516	SB	snag	2.5	30	Engelmann Spruce
TTWO	5546	TI	stub	3	75	Engelmann Spruce
TTWO	5549	OG/CC	live tree	10	0	Engelmann Spruce
TTWO	5516	SI/OG	live tree	12	5	Engelmann Spruce
TTWO	5546	OG	live tree	7	7.5	Engelmann Spruce
BBWO	5546	SI	live tree	9	100	Subalpine Fir
BBWO	5516	TI	snag	4	100	Lodgepole Pine
BBWO	5516	SB	stub	4	20	Subalpine Fir
BBWO	5516	SB	stub	1.8	100	Engelmann Spruce
BBWO	5547	SI	snag	5	250	Subalpine Fir
MOBL	5547	SB	stub	2.5	50	Subalpine Fir
MOBL	5547	SB	stub	3.5	75	Subalpine Fir
MOBL	5546	SB	stub	2.5	75	Subalpine Fir
MOBL	5516	SI	stub	27	75	Subalpine Fir
MOBL	5516	SI	snag	11.5	75	Subalpine Fir
TRSW	5547	TI	snag	7	100	Subalpine Fir
TRSW	5516	SB	stub	2.5	30	Engelmann Spruce
TRSW	5549	CC	stub	3	200	Engelmann Spruce
TRSW	5516	SB	stub	3	20	Subalpine Fir

TTWO = three-toed woodpecker, BBWO = black-backed woodpecker, MOBL mountain bluebird, TRSW = tree swallow (Campbell 1998)

6.0 DISCUSSION

Cavity nesting birds made extensive use of the three treatments where stubs or islands of timber were retained (SB, TI, and SI) for various aspects of their life histories. All cavity nesting species on which habitat use surveys were conducted were observed

foraging more often in these treatments relative to CC areas. The treatments also provided reproductive habitat for these species. Three-toed woodpeckers, black-backed woodpeckers, hairy woodpecker, tree swallow, mountain bluebirds, and red-breasted nuthatches nested within these three treatment areas. American kestrels were the only cavity nesting species that appeared not to nest within the treatment areas. The structural complexity afforded by the 3-metre stubs and residual tree islands provided invaluable foraging and nesting habitat for cavity nesting species even though the blocks were harvested relatively recently. The use of these structural components may increase with further decay.

6.1 Three-toed Woodpeckers

During the behavioural surveys, three-toed woodpeckers were only observed in treatments with live tree retention areas (TI and SI). This was expected as three-toed woodpeckers are adapted to forested ecosystems, often found in coniferous forests adjacent to openings (Campbell *et al.* 1990). The Donna Creek cutblocks may have simulated a "coniferous forest with openings" as a high density of three-toed woodpecker nests were recorded in the Donna Creek study blocks (R.W. Campbell, pers. com.). Similar habitat selection was documented for three-toed woodpeckers in Deschutes National Forest, Oregon (Goggans *et al.* 1988). Data from this study suggest that these birds tended to avoid the open treatments (SB and CC) but used the TI and SI treatments close to the edge for foraging and nesting. In the Donna Creek study area six of nine nests were discovered in the old-growth adjacent to the SB, SI, and TI treatments; no nests were found in the old-growth adjacent to the clear-cut treatments. The other three nests were found in the TI and SB treatments immediately adjacent to the old-growth.

The behavioural observations suggest that these birds prefer live trees to any other habitat feature (87% of observations were recorded on live trees). Three-toed woodpeckers that foraged within the cutblock boundaries, were observed only in tree islands close to the cutblock edges. This suggests that some foraging and nesting habitat for three-toed woodpeckers was provided by the tree retention areas near the edge and that they are still heavily dependent on the surrounding old-growth for foraging.

6.2 Black-backed Woodpeckers

Black-backed woodpeckers were more tolerant of conditions created by residual tree islands and three meter stubs relative to three-toed woodpeckers. Black-backed

woodpeckers built their nests in SB, TI, and SI treatments near the centre of the cutblocks and foraged in the open SB treatments.

During habitat use surveys black-backed woodpeckers were only observed in SB treatments. However these birds were observed outside of the habitat use surveys foraging and nesting in TI and SI treatments. In an unmanaged landscape, these birds tend to forage on dead trees, particularly in burned-over areas, sloughing off bark in pursuit of larvae and other grubs (Marshall 1992). Retention of 8-10 stubs/hectare may simulate the high snag densities and open conditions found in burned coniferous forest habitat.

As with three-toed woodpeckers, black-backed woodpecker nesting densities were high in the Donna Creek Study Area (R.W. Campbell, pers. comm.). Three nests were located within a single 120 hectare block (5516), 2 in SB and 1 in TI treatments. In the stub treatment, black-backed woodpeckers showed a strong general preference for stubs over other available habitat structures (89% of observations on stubs). As in burned habitat, stub treatments provided an abundance of dead snag-like structures on which black-backed woodpeckers foraged.

6.3 Mountain bluebirds

Mountain bluebirds require open country habitat for foraging and secondary cavities in stubs or snags for nesting. Without stubs or snags with pre-drilled cavities, mountain bluebirds would not find suitable nesting habitat in the cutblocks and could not locate territories there. Elevated features such as stubs, snags, and live trees were used as foraging perches.

In particular, stubs appeared to be of critical importance to this species, both as nest locations and as foraging structures. Three of five mountain bluebird nests located were in stubs; they appeared to prefer stubs to perch on and were even recorded mating on these structures. Mountain bluebirds tended to forage relatively close to their nest sites, reducing energetically expensive long-distance flights and allowing them to defend their nest sites from predators. Mountain bluebirds were therefore observed less in treatments they did not nest in. They were not observed in TI treatments and only 5% of the mountain bluebird observations were in the CC (neither treatments contained stubs). As nests were only found in treatments that contained stubs (SB and SI), and the majority of observations were recorded in these treatments (94.5%), stubs may be an important predictor of mountain bluebird presence.

6.4 Tree Swallows

Like many secondary cavity nesting birds, tree swallow presence is determined by the availability of suitable nesting sites (Muldal *et al.* 1985). Tree swallows nested in stubs (3 of 4 nests) and in snags (1 of 4 nests). Stubs and snags with available cavities appeared to be of critical importance to the reproductive capability of these birds in the Donna Creek study blocks. Tree swallows are aerial insectivores feeding almost entirely on highly mobile airborne insects (Muldal *et al.* 1985). In this study, tree swallows foraged extensively over all habitat types, at elevations up to, and greater than the height of the tallest tree. Therefore, foraging was not bounded by the structural complexity of their environment and nest sites appeared to be the only ecological requirement filled by the treatments.

6.5 American Kestrel

American kestrels inhabit open country usually in areas with hunting perches nearby (Cambell *et al.* 1990). At Donna Creek, American kestrels utilized stubs, snags and residual live trees as hunting perches in the SB, TI, and SI treatments. The number of observations were approximately equal in treatments where perching elements were available, and American kestrels were not observed in CC treatments. American kestrels were observed to prefer snags in islands and stubs as foraging perches over live trees. The foliage of live trees may restrict vision and be less efficient foraging perches than stubs or snags. Although a large proportion of this species habitat use was recorded as perching because American kestrels forage from perches it was often impossible to differentiate perching and foraging in the field. Therefore, the weighting of perching to foraging may be misleading. If foraging was recorded in a treatment, it was assumed that these birds were using that treatment for hunting. Behaviour patterns of American kestrels in SI and SB treatments were similar; they suggested these birds were actively foraging. American kestrels were not observed actively foraging in TI treatments. Snags replaced stubs as perching structures in the TI treatment.

7.0 SUMMARY

The extensive use of stubs and residual tree islands by the five target species illustrate their importance to the cavity nesting guild. That six of seven cavity nesting species recorded in the cutblocks nested in the SB, SI, and TI treatments further supports the importance of these structures to these species. From a management perspective,

retention of the structural complexity provided by stubs and residual tree islands can only be beneficial to most cavity nesting species.

Despite the preliminary positive results of cavity nesting birds in the treatment blocks reported here, it is important to remember that mountain bluebirds and American kestrels would not occur in this valley had it not been for the changes in habitat resulting from timber harvesting activity. Investigating which logging treatment best suited these species is therefore artificial, as they are an unnatural component of an undisturbed system. Likewise some cavity nesting species (brown creepers, boreal chickadees) that were common in the old-growth were not recorded anywhere in the treatment areas. Thus, although the retention of stubs and tree islands may be beneficial for some cavity nesting species, it falls far short of satisfactory for others.

8.0 RECOMMENDATIONS

8.1 Discussion of sampling design

The goal of the habitat use surveys was to follow a randomly selected bird within a treatment block. However, there were a number of biases associated with the study design.

- With few cavity nesting birds within the cutblocks, the time series were essentially comprised of many observations of the same few individuals.
- As the detectability of many of the birds was much higher at or near their nests many of the time series began there. This may have caused misleading results.
- Many of the birds were difficult to follow for any length of time, and as a result three observers were involved in following and recording birds. This may have caused changes in the normal activities and habitat preferences of the targeted bird.

As a result of all these inherent biases, the conclusions obtained from the results may indicate trends but cannot be used to form any conclusions about logging treatment or habitat selection.

No statistics were done on the data as they were considered more anecdotal than systematic. The sample sizes would not have stood even the most robust of statistical tests, and long strings of consecutive observations tend to lack statistical independance (Kenward 1987). These data are retrospective observations and cannot lead to very strong inferences. We have tried, however to avoid the temptation of going too far in developing *ad hoc* explanations of the data.

8.2 Direction for future research

In order to make stronger inferences about the results, habitat structure surveys should be conducted to determine the proportion of live trees, dead trees, snags, and shrubs in the treatments . This would facilitate a better understanding of the structural preferences of cavity nesting species for various activities (did they select stubs over small trees even though there was a much higher proportion of live trees present?). Habitat structure surveys that tie breeding bird and habitat use surveys together may help to clarify some of the results. Continuing the habitat use time series methodology without evaluation of the structural habitat is not recommended.

Nest searches in the treatment blocks provided meaningful data and the scope could be expanded. As well as nest location, nest success could be measured by monitoring the number of eggs, hatchlings, and fledglings using a dental mirror and a ladder. From this information collected over the long term, it could be determined if the nesting birds in the cutblocks represent a source or sink population.

Radiotelemetry is the most commonly used and widely accepted technique for habitat use studies (Cannings 1987, Carey *et al.* 1989). If funding permits, a number of cavity nesters could be radiotagged to eliminate all of the aforementioned sources of bias within the habitat use survey methodology. Radiotelemetry would be especially profitable with far-ranging species such as tree swallows and American kestrels.

The Donna Creek project is targeted towards assessing the effects of alternative harvesting techniques on cavity-nesting species. However, the response of nocturnal species, such as owls, is not being addressed by the current sampling methodology. Crepuscular and night-time playback censuses (following methodologies outlined by the British Columbia Resources Inventory Committee) should be conducted regularly throughout the owl breeding season to determine species using the treatment cutblocks relative to the clear-cut control blocks (ie. in all six blocks in the study area). Treatment use and/or tree island use should be assessed, although this may not be possible using playback methodology alone.

Valuable research could also investigate bat use of the structures retained in the cutblocks. Remote bat detection using a combination of tunable ultrasonic bat detector, "talking" clock, and a voice activated tape recorder (Chatwin 1995) would determine relative abundance of bats in the different treatments. To identify species, a netting program could be set up in conjunction with the remote bat detection. The best approach would be to also conduct radiotagging to identify day and night roosts. However, another cheaper technique that has been used with some success is the application of fluorescent visual marker tags to bats.

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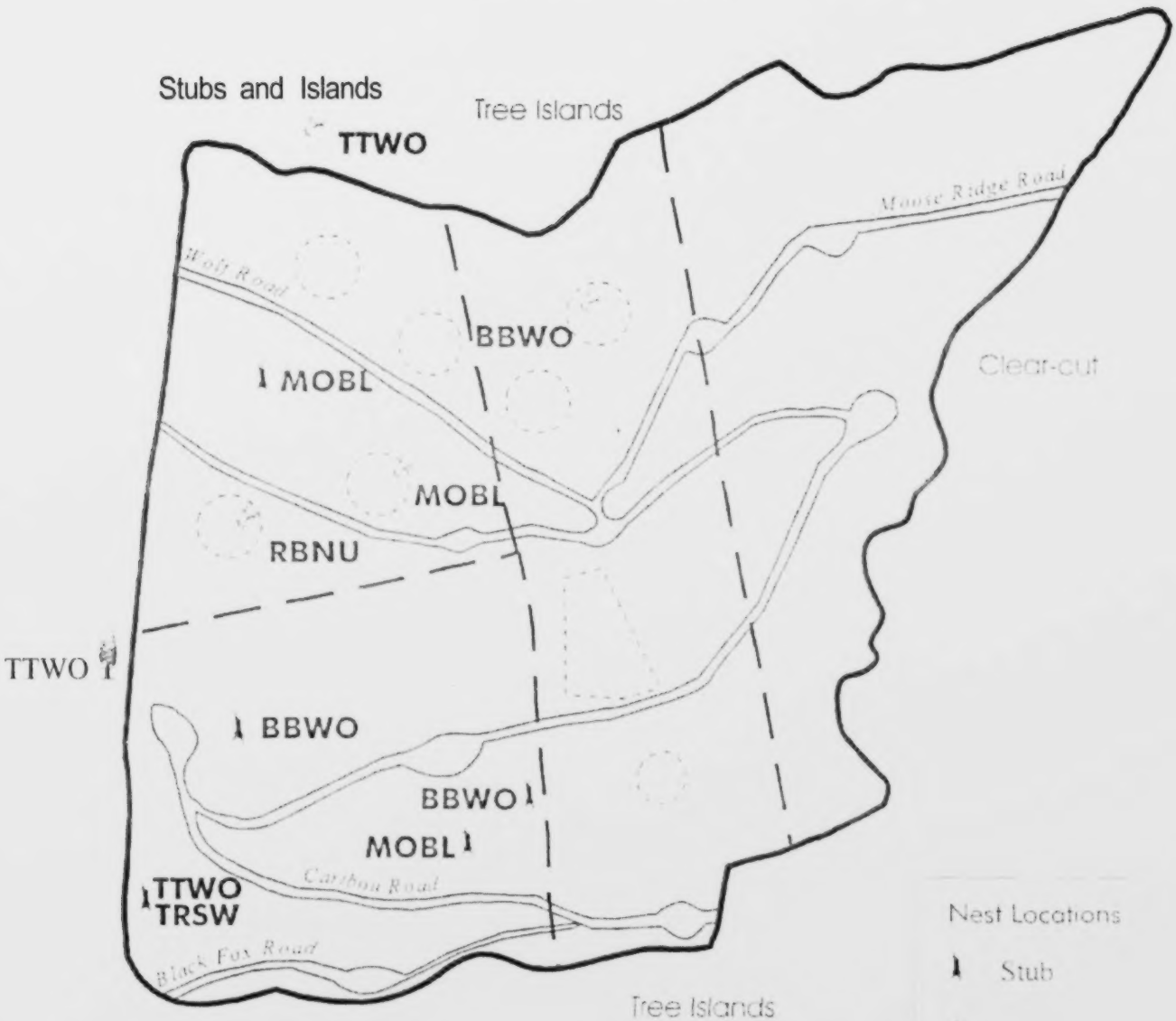
APPENDIX A: Cavity Nest Locations in the Donna Creek Study Area

Cavity Nest Locations In Block 5516

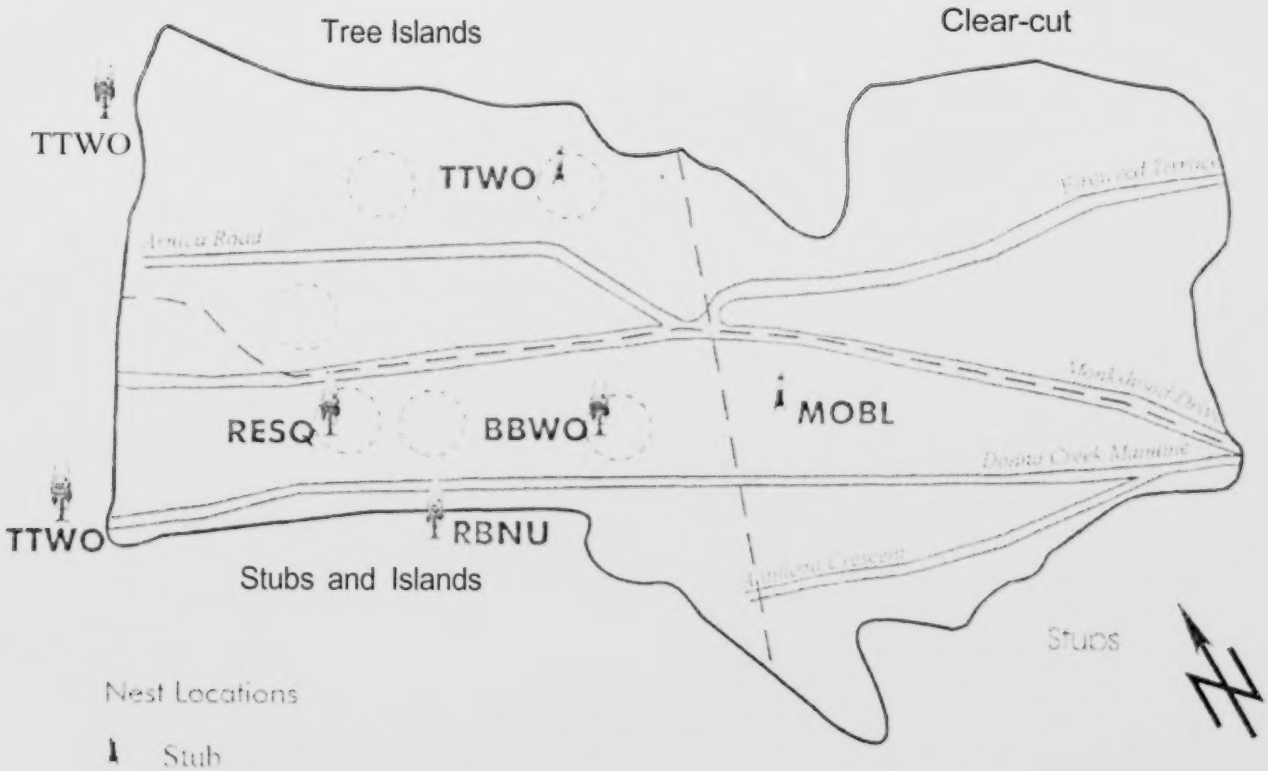


Stubs

SPECIES LEGEND

BBWO	Black-backed Woodpecker
TTWO	Three-toed Woodpecker
HAWO	Hairy Woodpecker
RBNU	Red-breasted Nuthatch
TRSW	Tree Swallow
MOBL	Mountain Bluebird

Cavity Nest Locations In Block 5546



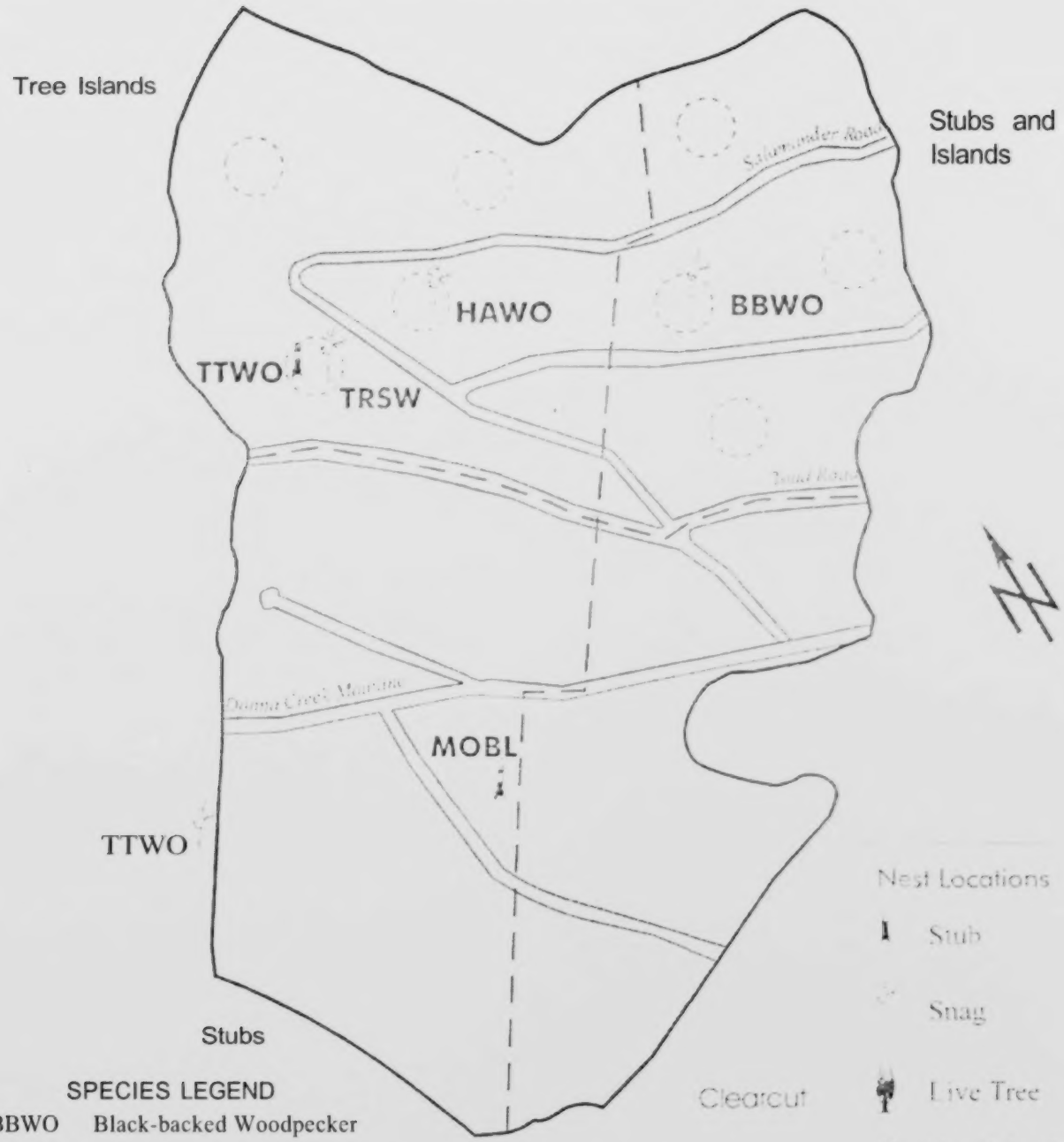
Nest Locations

- Stub
- Snag
- Live Tree
- Tree Island
- Treatment

SPECIES LEGEND

BBWO	Black-backed Woodpecker
TTWO	Three-toed Woodpecker
HAWO	Hairy Woodpecker
RBNU	Red-breasted Nuthatch
TRSW	Tree Swallow
MOBL	Mountain Bluebird
RESQ	Red Squirrel

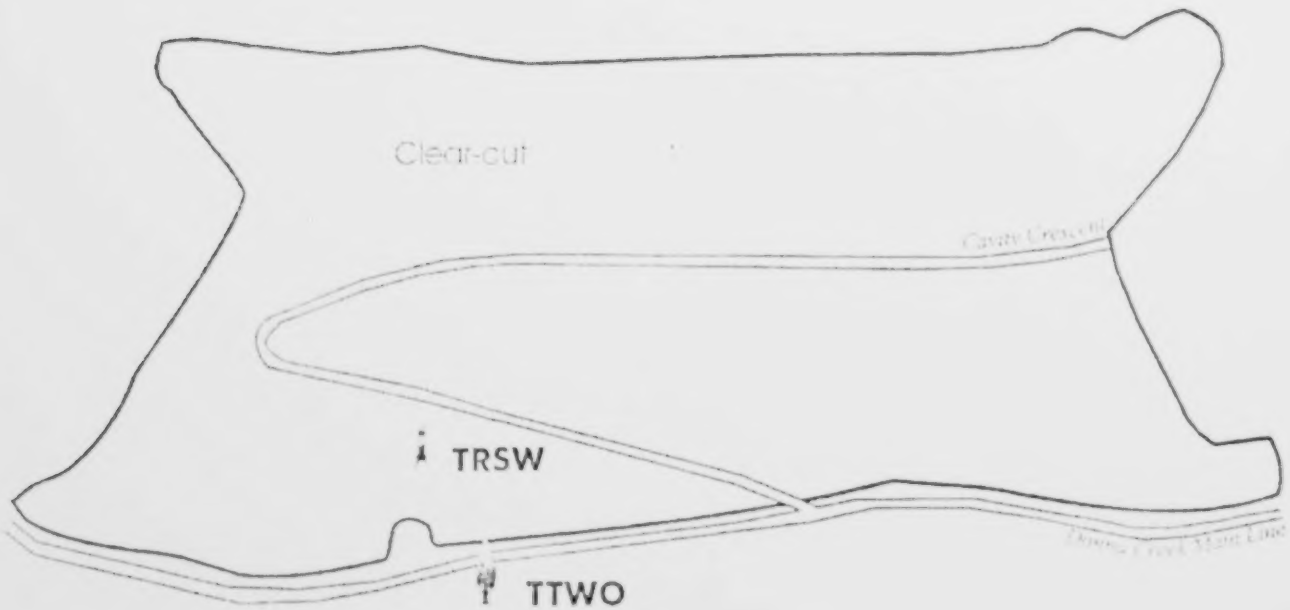
Cavity Nest Locations In Block 5547



SPECIES LEGEND

BBWO	Black-backed Woodpecker
TTWO	Three-toed Woodpecker
HAWO	Hairy Woodpecker
RBNU	Red-breasted Nuthatch
TRSW	Tree Swallow
MOBL	Mountain Bluebird

Cavity Nest Locations In Block 5549



SPECIES LEGEND

TTWO Three-toed Woodpecker

TRSW Tree Swallow

Nest Locations

Stub

Live Tree